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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA-15135 (MARCH 2003)
NASA
SUPERSEDING NASA-15135 (MARCH 2001)

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NASA-15135 (MARCH 2003)
NATIONAL AERONAUTICS **NASA**
AND SPACE ADMINISTRATION **SUPERSEDING NASA-15135 (MARCH 2001)**

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SECTION 15135

CENTRIFUGAL PUMPS
03/03

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NOTE: Delete, revise, or add to the text in this section to cover project requirements. Notes are for designer information and will not appear in the final project specification.

This section covers centrifugal pumps.

Schedule project chilled-water, dual-temperature, and condenser water pumps by sequential numbering with the letter P prefix. For example: P-1, P-2, P-3, etc. Schedule class of pump: e.g., Class ADS, as specified herein.

Under the heading "Special Requirements," specify any detail, deviation, or waiving of requirements, which is pertinent only to specific pumps.

The following parameters cover a wide spectrum of specification criteria to suit project conditions. Selections shall be carefully checked to ensure equivalence and compliance by at least three manufacturers.

Motors are covered in Section 16225, "Motors."

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: The following references should not be manually edited except to add new references. References not used in the text will automatically be deleted from this section of the project specification.

****

The publications listed below form a part of this section to the extent referenced:

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 11	(1990) Load Ratings and Fatigue Life for Roller Bearings
ABMA 9	(1990) Load Ratings and Fatigue Life for Ball Bearings

ASME INTERNATIONAL (ASME)

ASME B16.1	(1998) Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

HYDRAULIC INSTITUTE (HI)

HI SCRRP	(1994) Standards for Centrifugal, Rotary and Reciprocating Pumps

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940/1	(1986) Mechanical Vibration - Balance Quality Requirements of Rigid Rotors - Part 1: Determination of Permissible Residual Unbalance
ISO 2858	(1975) End Suction Centrifugal Pump (Rating 16 Bar) Designation Nominal Duty Point and Dimensions
ISO 5199	(1986) Technical Specifications for Centrifugal Pumps, Class II
ISO 7005-2	(1988) Metallic Flanges Part 2: Cast Iron Flanges

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP 51	(1991; R 1995) Class 150 LW Corrosion Resistant Cast Flanges and Flanged Fittings
MSS SP-86	(1987; R 1992) Guidelines for Metric Data in Standards for Valves, Flanges, Fittings and Actuators

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA MG 1	(1998) Motors and Generators

1.2 DESIGN REQUIREMENTS

[Pumps shall be designed using hydraulic criteria based upon actual model developmental test data. Manufacturer shall certify that pumps have been

hydraulically tested at the factory.]

Pumps shall be selected at a point within the maximum efficiency for a given impeller casing combination. Deviations within 3 percent of maximum efficiency are permissible, provided the lesser efficiency is not less than the scheduled efficiency.

Pumps having impeller diameters larger than 90 percent of the published maximum diameter of the casing or less than 15 percent larger than the published minimum diameter of the casing will be rejected.

Acceptable maximum impeller diameter calculations shall not be based on percentage of impeller diameter range for a given casing. Shop drawings will be approved only if complete performance curves for all impeller sizes for a given casing are included in the submittal.

[Where parallel-pump operation is indicated, pumps selected shall have characteristics specifically suitable for the service without unstable operation.]

[When Net Positive Suction Head (NPSH) calculations are made, inlet-storage head shall be considered at empty point and the centerline pump location shall include not less than a 6-inch 150 millimeter concrete base.]

[Pumps shall be suitable for operation at indicated temperature without vapor binding and without cavitation under any system operating condition. The only acceptable means of rectification of cavitation shall be replacement of entire pump assembly.]

Available Net Positive Suction Head (NPSH) shall exceed required NPSH by not less than 1-1/2 feet 0.46 meter.

Pumps of the same duty condition, classification, and accessories, or with specified accessory deviation, shall be identical and the product of one manufacturing source.

Pumps from more than one manufacturing source shall be provided only when a single manufacturing source is unable to meet all specification requirements.

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01330, "Submittal Procedures," and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control. Include a columnar list of appropriate products and tests beneath each submittal description.

****

The following shall be submitted in accordance with Section 01330,

"Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Installation drawings for centrifugal pumps shall be submitted in accordance with Part 3, "Execution," of this section.

SD-03 Product Data

The following shall be submitted for centrifugal pumps in accordance with paragraph entitled, "General Requirements," of this section.

Equipment and Performance Data
Equipment Foundation Data

SD-05 Design Data

Design Analysis and Calculations shall be submitted for centrifugal pumps in accordance with paragraph entitled, "General Requirements," of this section.

SD-06 Test Reports

Test reports for pumps shall be submitted on the following tests:

Hydraulic Tests
Efficiency Tests
Vibration Tests
Output Efficiency
Surface Hardness Tests
Deflection Tests

SD-07 Certificates

Certificates shall be submitted for the following items showing conformance with the referenced standards contained in this section.

Base-Mounted Centrifugal Pumps
Line-Mounted Pumps
Accessories

1.4 GENERAL REQUIREMENTS

****

NOTE: If Section 15003, "General Mechanical Provisions," is not included in the project specification, applicable requirements therefrom should be inserted and the following paragraph deleted. If Section 15072, "Vibration Isolation for Air Conditioning Equipment," is not included in the project specification, applicable requirements

therefrom should be inserted and the second paragraph deleted. If Section 16225, "Motors" is not included in the project specification, applicable requirements therefrom should be inserted and the third paragraph deleted.

****

[Section 15003, "General Mechanical Provisions," applies to work specified in this section.]

[Section 15072, "Vibration Isolation for Air Conditioning Equipment," applies to work specified in this section.]

[Section 16225, "Motors" applies to this section.]

Design Analysis and Calculations shall show NPSH (net positive suction head) calculations for centrifugal pumps.

Equipment and Performance Data consisting of pump curves (gallons liter per minute versus total head in feet millimeter per rpm) shall be provided for each type centrifugal pump.

Equipment Foundation Data shall be submitted for centrifugal pumps.

1.4.1 Factory Tests

The following tests shall be submitted from the manufacturer prior to shipping the pump from the factory, hydraulic tests, efficiency tests, vibration tests, output efficiency tests, surface hardness tests, and shaft deflection tests.

PART 2 PRODUCTS

****

NOTE: Paragraph entitled, "General Pump Requirements," applies to engineered quality pumps. See paragraph entitled, "Base-Mounted Centrifugal Pumps," for building-trades quality base-mounted pumps.

****

****

NOTE: Pump and motor balance shall conform to ISO 1940/1 - (1986) Balance Quality Requirements of Rigid Rotors - Determination of Permissible Residual Unbalance unless otherwise noted. Motor vibration levels shall conform to NEMA Specification MG-1, Motors and Generators, Part 7 unless otherwise noted.

****

2.1 GENERAL PUMP REQUIREMENTS

Certificates for pumps and Accessories shall show conformance with the referenced standards contained in this section.

This specification includes design, construction, installation, and performance features of centrifugal water pumps. Pumps provided shall conform to HI SCRRP ISO 5199 and ISO 2858 standards for centrifugal pumps, and to requirements specified herein.

2.1.1 Classification

Class ADS: Axially (horizontally) split-case, single-stage, double-suction, single- or double-volute centrifugal type

****
NOTE: Limit all end-suction pumps to 1,000 gpm at 100 psi 4.0 cubic meter per minute at 690 kilopascal.
****

Class FES: Radially (vertically) split-case, single-stage, frame-mounted distance piece or back pullout end suction, single- or double-volute centrifugal type

Class CES: Radially (vertically) split-case, single-stage, close-coupled, distance piece end-suction, single- or double-volute centrifugal type

2.1.2 Casing

Pump casings shall be bronze-fitted, seasoned cast iron with a design working pressure of not less than 185 pounds per square inch gage (psig) at 100 degrees F 1275 kilopascal at 38 degrees C. Casings shall be single or double volute with flanged piping connections conforming to ASME B16.1, MSS SP 51, MSS SP-86 and ISO 7005-2, Class 125 psi. Direction of shaft rotation shall be conspicuously indicated. Casing shall have tapped openings for air venting, priming, draining, and suction and discharge gages. A brass or bronze umbrella or vent cock shall be furnished for venting except where automatic air vents are indicated. Drain openings in the volute, intake, or other passages capable of retaining trapped water shall be located in the low point of such passages.

Casing construction shall be such that packing seals may be substituted in the field for mechanical seals without machining.

****
NOTE: If a paragraph is applicable to a certain project pump only, rewrite and identify project pump number.
****

Packing-box depth shall accommodate [six rings of square packing, lantern ring, and throttling bushing.] [not less than five rings of square packing, lantern ring, and throttling bushing.] [not less than four rings of square packing, lantern ring, and throttling bushing.]

2.1.3 Distance Piece

A suction end distance piece shall be provided with each end suction pump

as a part of the pump or piping system.

2.1.4 Impellers

Impellers shall be enclosed cast bronze or corrosion-resistant steel, machined and polished. Waterways shall be machine- or hand-finished. Impellers shall meet maximum and minimum diameter requirements.

2.1.5 Balancing

****

NOTE: Balance is the process of improving the mass distribution of the pump components in order to minimize damaging centrifugal forces. No component can be perfectly balanced. there will always be some remaining unbalance. The minimum recommended balance grade is ISO grade 2.5. Select an ISO grade or insert a standard.

****

Pump impeller assemblies shall be statically and dynamically balanced to ISO 1940/1-1986, [G6.3][G2.5][G1.0][ ]. Correction planes needed for additional weight mass for balancing shall be determined by using a calibrated and certified balancing machine capable of identifying the magnitude and angular position of any unbalance of the impeller.

2.1.6 Wearing Rings

Wearing rings shall be dissimilar bronze composition for nongalling service. Wearing rings shall be provided in every pump case and on all impellers larger than 7 inches 175 millimeter in diameter.

2.1.7 Shaft

[Shafts for convertible packed or mechanical seal service shall be solid sleeveless AISI 400 series corrosion-resistant steel hardened to 425 Brinell in packing area, or sleeved type with AISI 300 series corrosion-resistant steel shaft and AISI 400 series corrosion-resistant steel sleeves hardened to 425 Brinell.]

[Shafts for packed seal service shall be sleeved and all materials shall be AISI Type 304 corrosion-resistant steel. Surfaces in packing area shall be plasma-spray-coated alumina ceramic with a coefficient of expansion compatible with the substrate. Surface hardness shall be 900 Brinell.]

[Shafts for mechanical-seal service shall be solid or sleeved and all materials shall be AISI Type 304 or 316 corrosion-resistant steel.]

[Press-fitted sleeves are not acceptable.]

****

NOTE: Select the following paragraph only when Class CES pumps are specified.

****

Motor shafts of close-coupled pumps shall be manufacturer's standard AISI 18-8 corrosion-resistant steel and finish.

Surfaces shall have a 16-microinch 406 nanometer surface finish where packing is specified or where a pump must be convertible to packing seals from mechanical seals. Pump shafts to be sealed by mechanical seals only shall have a 32-microinch 815 nanometer surface finish, or better.

[End-suction pump shafts shall have an impeller nut that completely encloses shaft end threads and seals tight to the impeller.]

****

NOTE: If a service requires extended operation at or near shutoff head or far out on the curve, this operating condition must be specified. Check permissible shaft deflection for possible revision.

Specify manual or automatic bypass system if necessary.

****

Shaft construction shall be substantial to prevent seal or bearing failure due to vibration. Shaft vibration at pump-seal face shall conform to the paragraph entitled, "Pump Acceptance," under shutoff-head operating conditions. Flow from 1/4-inch DN6 iron pipe size (ips) pipe shall be provided during testing.

Shaft shall be equipped with bronze or nylon water slingers at each bearing and shall be sealed at the casing interface with a bronze throttling bushing.

2.1.8 Packing Seals

Packing shall be soft woven non-asbestos material with not less than 25 percent by weight of tetrafluoroethylene resin. Pump shall be shipped to the site without the packing inserted and shall be packed on site in the presence of the pump or packing manufacturer's representative. At no time during startup or run-in shall the gland drip less water than 80 drops per minute. After a minimum of 40 operating hours and upon permission of the Contracting Officer, leakage rate may be reduced to 50 drops per minute or to the rate recommended by packing manufacturer.

Gland shall be split-bronze type with AISI 18-8 corrosion-resistant steel eyebolts and pins or studs. Hex-nuts shall be bronze or nongalling corrosion-resistant steel.

Stuffing boxes exposed to below atmospheric pressure at any operating condition, including starting, shall be provided with a water seal. Water seal shall consist of nonferrous lantern ring or a seal cage and required connections to the pump case.

2.1.9 Mechanical Seals

****

NOTE: Where pump duty conditions include severe on/off or extreme of either end-of-curve operation, pump should be packed only, or one packed and one mechanically sealed pump should be specified with the latter pump convertible to packing.

****

Mechanical seals shall be balanced or unbalanced, as necessary to conform to specified service requirements. Mechanical seals shall be constructed in a manner and of materials particularly suitable for the temperature service range and chemical analysis of water being pumped.

Cooling-water characteristics for seal construction purposes are as follows: makeup total dissolved solids of 200 parts per million (ppm) cycled up to five times, containing not more than 600 ppm of hexavalent chromate, and pH not less than 6.0.

Seal construction shall not require external source cooling for pumped-fluid service temperatures up to 250 degrees F 121 degrees C.

Seal pressure rating shall be suitable for maximum system hydraulic conditions.

Materials of construction shall include AISI 300 series corrosion-resistant steel, solid tungsten-carbide rotating-seal face, and Buna-N vinylidene-fluoride-hexafluoropropylene, EPT, or tetrafluoroethylene seals.

****

NOTE: Where suspended solids are present, specify filters or separators on flush water line. See paragraph entitled, "Centrifugal Abrasives-Separators," in this section.

****

Bypass flushing water supply shall be free of iron rust products and other abrasive materials and shall be directed onto face of seal without dead ending. All piping and accessories shall be provided.

Throttling bushing shall have clearances to minimize leakage in case of complete seal failure without restriction of flushing water.

Mechanical seals shall not be subjected to hydrostatic test pressures in excess of the manufacturer's recommendations.

Mechanical-seal manufacturer's representative shall direct on-site seal installation, testing, adjustment, and placing-into-service operations and shall instruct facility personnel as scheduled by the Contracting Officer.

2.1.10 Centrifugal Abrasive-Separators

****
NOTE: Select the following for cleansing of dirt-laden water from discharge of pump used to flush and cool mechanical or packing seals.

Check manufacturer's catalog for pressures required, particle-size removal, and fluid-flow data.
****

Pump seals shall be flushed with pump discharge water cleansed by centrifugal force in a cyclone abrasive-separator. Separator shall be constructed of AISI Type 316 corrosion-resistant steel. Underflow shall be piped to waste.

2.1.11 Bearings and Lubrication

****
NOTE: Select the following for engineered-quality pumps only. Rewrite to require double-row thrust bearings for heavy-duty service.
****

Bearings shall be heavy-duty ball or roller type with full provisions for the mechanical and hydraulic radial and thrust loads imposed by any normal service condition. Bearings shall be manufactured from vacuum-degassed or processed-alloy steel. Thrust-bearing endplay shall not exceed 0.005 inch 0.127 millimeter. Thrust bearings shall be secured to the shaft by threaded collar and locknut. Double-row ball or roller bearings shall be self-aligning. Bearings shall have an L-10 rated life of not less than [30,000][50,000][80,000][ ] hours in accordance with ABMA 9 or ABMA 11. Shop drawings shall bear manufacturer's certification of bearing life.

****
NOTE: For commercial quality pumps and certain engineered-quality pumps, select the following paragraph.
****

Bearings shall be heavy-duty ball or roller type with full provisions for the mechanical and hydraulic radial and thrust loads imposed by any normal service condition. Bearings shall be manufactured from vacuum-degassed or processed-alloy steel. Bearings shall have an L-10 rated life of not less than [30,000][50,000][80,000][ ] hours in accordance with ABMA 9 or ABMA 11. Shop drawings shall bear manufacturer's certification of bearing life.

****
NOTE: Normally select grease-lubricated bearings for low temperatures to minimize condensation and contamination.
****

[Bearings shall be permanently lubricated sealed bearings]

[Bearings shall be grease lubricated and shall be provided with grease supply and relief fittings located at bottom of bearings.]

[Bearings shall be oil-flood lubricated. Oil sumps shall be fitted with 4-ounce 120 milliliter constant-level sight oilers and positive means of sump drainage and condensate detection. Provisions shall include FM-approved brass cocks connected to lowest part of bearing sump.]

Bearing housings shall be cast iron, self-aligning on metal-to-metal surfaces and shall totally enclose bearings.

2.1.12 Flexible Coupling

Pump shaft shall be connected to the motor shaft through a flexible coupling. Flexible member shall be a tire shape in shear, or a solid-mass serrated-edge disk shape made of chloroprene materials and retained by fixed flanges. Flexible coupling shall act as a dielectric connector and shall not transmit sound, vibration, or end thrust.

[All couplings in intermittent on/off service shall have couplings selected on the basis of a 2.0 service factor. Other service factors shall be in accordance with the manufacturer's instructions.]

[Pumps shall be provided with spacer couplings.]

2.1.13 Bedplate

Pump and driver shall be mounted on a common bedplate, hollow cast iron, multiribbed for maximum rigidity, with adequate number of grout holes and grout air vents, and with drip rim and drain tapping.

Contractor shall submit for approval, when specified, a fabricated steel base constructed of a rolled structural-steel perimeter frame, reinforced and cross-braced internally with pipe or rolled structural members, capped with 1/4 inch 6 millimeter steel plate, and provided with adequate grout holes, grout air vents, drip rim, and drain tapping. Formed or bent steel bedplates are not acceptable.

2.1.14 Motors

Pump motors shall be checked for current direction of rotation only after pumps have been primed and approved by the manufacturer's representative and the Contracting Officer.

Motors shall conform to NEMA MG 1

2.1.15 Special Requirements

****

NOTE: Specify hereunder any detail, deviation, or waiving of requirement which is pertinent only to specific pumps. Write in headings such as P-1 and P-2, select provided paragraphs, or delete provided

paragraphs and write new paragraphs to suit project conditions. For example: pump P-1 shall be fitted with mechanical seals and pump P-2 shall be fitted with packing seals, pump P-4 shall be exempt from vibration testing.

Class ADS: Provide title and specify any detail requirements pertinent only to this class of pumps.

****

Plugged or valved casing drains which may require ips red-brass pipe shall be brought out beyond periphery of casing to facilitate drainage. Volute plugs at flanges shall be assembled with tetrafluoroethylene tape.

****

NOTE: Class FES or CES: Provide part title and specify hereunder any detail requirements pertinent only to this class and series of pumps.

Class CES pump selections should be limited to 5 horsepower power of 3.75 kilowatt and less. These pumps have special motor shaft requirements. For critical operations where end-suction pumps are desired, use Class FES pumps.

****

Pump casing and pump motor shall be mounted on a single pedestal and shall not require a bedplate. Pump casing drain shall be plugged.

****

NOTE: For very small pumps of one horsepower power of 0.75 kilowatt and less, select either or both of the following two paragraphs after checking manufacturer's literature.

****

Pump casing with threaded inlet and outlet connections shall be furnished.

Pump casing and impeller wear rings shall be furnished.

Pump motor shall be an extended-shaft type with special heavy-duty thrust and radial bearings to accommodate motor and pump thrust loads. Impeller shall be mounted directly on the motor-shaft extension.

****

NOTE: For frequent start/stop or near shutoff head operation and for better extended-shaft support, specify packing.

****

Pump seals shall be packed type.

****

NOTE: For very small off-the-shelf pumps, select

the following in lieu of preceding paragraph.
****

Pump seals shall be packed type or have the manufacturer's standard mechanical seals for the specified service.

2.2 BASE-MOUNTED CENTRIFUGAL PUMPS

****
NOTE: The following is a short-form specification with minimum requirements for building trades quality, base-mounted pumps. Review project requirements and supplement the following as necessary.

When using this part, delete paragraph entitled, "General Pump Requirements," and subparagraphs.
****

Pumps provided shall conform to HI SCRRP ISO 2858 and ISO 5199 standards for centrifugal pumps and to requirements specified herein.

2.2.1 Pump Schedule

Pump capacity design requirements, and characteristics not specified herein shall be as indicated on the pump schedules.

2.2.2 Classification

****
NOTE: Select from the following or include description in schedule.
****

Pump class shall be as scheduled.

Class ADS, axially (horizontally) split-case, single-stage, double-suction, centrifugal type

****
NOTE: Limit all end-suction pumps to 1,000 gpm at 100 psi 4.0 cubic meter per minute at 690 kilopascal.
****

Class FES, radially (vertically) split-case, single-stage, frame-mounted, end-suction centrifugal type

2.2.3 Pump Selection

****
NOTE: Check hydraulic conditions for each application with at least three manufacturers to assure compliance with the following efficiency conditions.

****

Pumps shall be selected at the point of maximum efficiency for a given impeller/casing combination. Deviations within 3 percent of maximum efficiency are permissible, provided that the efficiency is not less than the scheduled efficiency. Pumps having impeller diameters larger than 90 percent of the published maximum diameter of the casing or less than 15 percent larger than the published minimum diameter of the casing will be rejected.

****

NOTE: A centrifugal pump always operates at the intersection of its head-capacity curve and the system curve that shows the head required to make the liquid flow through the system of piping, valves, and fittings.

****

2.2.4 Balancing

****

NOTE: Pump and Motor balance shall conform to ISO 1940/1 - (1986) Balance Quality Requirements of Rigid Rotors - Determination of Permissible Residual Unbalance unless otherwise noted. Motor vibration levels shall conform to NEMA Specification MG-1, Motors and Generators, Part 7 unless otherwise noted.

****

Pump impeller assemblies shall be statically and dynamically balanced to ISO 1940/1-1986, [G6.3] [G2.5] [G1.0] [_____] minimum. Correction planes needed for additional weight mass for balancing shall be determined by using a calibrated certified balancing machine capable of identifying the magnitude and angular position of any unbalance of the impeller.

2.2.5 Casing

****

NOTE: Review casing pressure rating.

****

Pump casing shall be bronze-fitted cast iron with a design working pressure of not less than 125 psig at 200 degrees F 862 kilopascal at 93 degrees C. Casing piping connections in 2-inch 50 millimeter and larger sizes shall be flanged and shall conform to ASME B16.1 MSS SP 51, MSS SP-86 and ISO 7005-2. Casing shall have trap-equipped openings for air venting, priming, draining, and suction and discharge gages. Pump shall be convertible to packing service without machining of casing.

2.2.6 Wearing Rings

Wearing rings shall be provided in every pump case and on all impellers larger than 8-inch 200 millimeter diameter.

2.2.7 Shaft

[Shaft shall be solid, sleeveless, AISI 400 series corrosion-resistant steel, hardened to 425 Brinell in stuffing-box area or sleeved type with AISI 300 series shaft and AISI 400 series corrosion-resistant steel sleeves hardened to 425 Brinell.]

Shaft vibration at sealing face shall conform to the paragraph entitled, "Pump Acceptance," when pump is operating against shutoff head.

2.2.8 Mechanical Seals

Mechanical seals shall be the manufacturer's standard for the specified and indicated service. Bypass flushing water supply shall be free of iron rust products and other abrasive materials and shall be directed onto face of seal without dead ending. All piping and accessories necessary to the function shall be provided.

2.2.9 Bearings and Lubrication

Bearings shall be heavy-duty ball or roller type and shall have an L-10 rated life of not less than [30,000][50,000][80,000][____] hours in accordance with ABMA 9 or ABMA 11.

****
NOTE: Select oil-lubricated bearings only for water-heating systems.
****

[Bearings shall be permanently lubricated sealed bearings]

[Bearings shall be grease lubricated unless otherwise specified and shall be provided with grease supply and relief fittings located at bottom of bearing.]

[Bearings for hot-water service shall be oil-flood lubricated. Oil sumps shall be fitted with 4-ounce 120 milliliter constant-level sight oilers and positive means of sump drainage and condensate detection. Provisions shall include FM-approved brass cocks connected to lowest part of bearing sump.]

2.2.10 Flexible Coupling

Pump shaft shall be connected to the motor shaft through an elastomeric flexible member in shear and shall be a tire shape or a solid-mass serrated-edge disk shape retained by fixed flanges. Flexible coupling shall act as a dielectric connector and shall not transmit sound, vibration, or end thrust.

2.2.11 Bedplate

Pump and driver shall be mounted on a common bedplate which shall be constructed for maximum rigidity, with an adequate number of grout holes and grout air vents and with drip rim and drain tapping.

2.3 LINE-MOUNTED PUMPS

****

NOTE: The following is limited to pumps up to and including 1 horsepower 0.75 kilowatt.

****

Pump shall be the capacity indicated.

Design, construction balancing, and vibration-isolation provisions shall conform to HI SCRRP ISO 5199 and ISO 2858 standards specifically for quiet waterside operation.

Pump casing and seal shall be suitable for operation at pressures up to 125 pounds per square inch 862 kilopascal at temperatures to 250 degrees F 121 degrees C.

Pump casing shall be cast [iron] [bronze].

Pump shall be single-stage, single-suction centrifugal-type, bronze, fitted with mechanical seal. Pump shaft shall be AISI 300 series corrosion-resistant steel or the manufacturer's standard alloy steel with nonferrous-metal-protected wetted surfaces. Coupling shall be elastomer-in-shear or four-spring type. Mechanical seal shall be designed for service with makeup water normal to the site and for 300 ppm of hexavalent chromate in the recirculating system. Pump bearings shall be oil-lubricated sleeve type, with oil reservoirs for extended periods of service without requiring added lubricant.

Motor shall have oil-lubricated sleeve bearings with oil reservoirs for extended periods of service, without requiring added lubricant, and shall be resiliently mounted.

PART 3 EXECUTION

3.1 PUMP PROTECTION

Before any pump is operated, sumps and piping systems shall be cleaned and flushed to remove all particles larger than 1000 micro meter or larger than one-half of the smallest pump axial or radial clearance, whichever is smaller. Permanent and temporary pipeline strainers shall be in place and shall be cleaned frequently to prevent cavitation. Temporary strainers shall not be removed until after system acceptance, unless otherwise approved.

Mechanical-seal flushing water shall be provided with centrifugal separator or 10-micrometer filter element where loose rust may be present at startup.

3.2 GROUTING

****

NOTE: Premature failure of seals and bearings can be caused by the deterioration of machinery bases

and foundations. The cause of the deteriorations is often due to loading of the base and/or foundation before the concrete or grout has properly cured.

****

Shimming, alignment, and grouting of pump, driver, and bedplate shall be in accordance with the most stringent requirements of the manufacturer's instructions and as specified herein. Grout shall cure a minimum of [28] [_____] days before being loaded. After grouting has cured, bedplate shall be hammer-tested for voids. Poor grouting, as evidenced by voids, shall require resetting of pump assembly.

3.3 VIBRATION ISOLATION

****

NOTE: Vibration-isolation provisions shall be selected for each application.

Mass of inertia block may be up to three times weight of supported assembly.

Drawings should show piping isolation, anchorage, and pump and pipe support details.

****

Vibration isolation shall conform to the provisions of Section 15072, "Vibration Isolation for Air Conditioning Equipment."

3.4 ALIGNMENT

Before attempting alignment, the contractor will demonstrate that the pump does not have any load/force imposed by the piping system. Minimum alignment values (below) are for pump and driver at normal running temperatures. Values must be compensated for thermal growth. Limited movement of the pump or driver (commonly known as bolt-bound) must be corrected to ensure alignment capability. Hold down bolts shall not be undercut in order to perform adjustment.

Shims shall be commercially die-cut, without seams or folds, and be made of corrosion resistant stainless steel. No more than four shims shall be used at any single point.

Units with drive motor over [7.5] [10] [15] [20] [25] hp shall have alignment jack bolts installed.

Pump and driver shall be aligned to the following minimum specifications:

Speed(RPM)	close-coupled offset (mils)	close-coupled angle(mils/in.)	spool piece angle (mils/in. @ coupling pt.)
600	6.0	2.0	3.0
900	5.0	1.5	2.0
1200	4.0	1.0	1.5
1800	3.0	0.5	1.0
3600	1.5	0.4	0.5

7200	1.0	0.3	0.4

[Pump alignment shall be performed under the direction of the manufacturer's representative.]

Final alignment settings shall be provided as part of the final test data.

Pump shall be dowelled in place with AISI 18-8 corrosion-resistant steel spiral-wrapped pins before being subjected to pressure or piping reaction. After grouting and final alignment, and no sooner than after 40 hours of continuous operation, the driver shall be similarly dowelled in place. Taper pins are not acceptable.

3.5 Vibration Analyzer

Contractor shall use an FFT analyzer to measure vibration levels. It shall have the following characteristics: A dynamic range greater than 70 dB; a minimum of 400 line resolution; a frequency response range of 5Hz-10 KHz(300-600000 cpm); the capacity to perform ensemble averaging, the capability to use a Hanning window; auto-ranging frequency amplitude; a minimum amplitude accuracy over the selected frequency range of plus or minus 20 percent or plus or minus 1.5 dB.

An accelerometer, either stud-mounted or mounted using a rare earth, low mass magnet and sound disk(or finished surface) shall be used with the FFT analyzer to collect data. The mass of the accelerometer and its mounting shall have minimal influence on the frequency response of the system over the selected measurement range.

3.6 PUMP ACCEPTANCE

Prior to final acceptance, vibration analysis shall verify pump conformance to specifications. Vibration levels shall not be more than .075 in/sec at 1 times run speed and at pump frequency, and .04 in/sec at other multiples of run speed.

Pump shall be operated and demonstrated to be nonoverloading at any operating point and that the flow capacity is as specified. Final test reports shall be provided to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --